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ABSTRACT: Applications of wetting-agent solutions produce mortality in birds. The exact cause of death is undetermined, but it is believed that destruction of the insulating qualities of the plumage permits ambient cold temperatures and evaporation to lower the body temperature to a lethal level. The original concept of using these materials as bird-control tools was developed in 1958 at the Patuxent Wildlife Research Center, Bureau of Sport Fisheries and Wildlife, Laurel, Maryland. Early field trials by personnel of the Division of Wildlife Services and the Denver Wildlife Research Center indicated that ground-application techniques had promise, but limitations of the equipment precluded successful large-scale roost treatments. In 1966, Patuxent Center personnel began using tanker-type aircraft to evaluate high-volume aerial applications of wetting agents. The success of these tests led to the use of small aircraft to make low-volume, high-concentration aerial applications just prior to expected rainfall. Recent trials of the low-volume method show that, with some limitations, it is effective, inexpensive, and safe to the environment.

Current research emphasizes the screening of new candidate materials for efficacy, biodegradability, and toxicity to plants and non-target animals, as well as basic investigations of the avian physiological mechanisms involved. Field trials to develop more effective application techniques will continue.

INTRODUCTION

Surface-active agents, or surfactants, are commonly defined as substances which lower the surface tension of the water to which they are added. Their potential for bird control is based on the fact that, under certain environmental conditions, external application of aqueous surfactant solutions causes mortality of birds. The exact physiological mechanisms involved in this mortality are not yet known, but we feel that wet plumage, resulting from a combination of surfactant application and rainfall, increases heat conductivity from the bird's body. This energy transfer is enhanced by evaporation. If the energy transfer is not met by increased metabolism, the bird's body temperature drops and, eventually, falls to a lethal level. The low inherent toxicity of most surfactants as compared with traditional avicides makes their use a relatively safe method of reducing depredating bird populations.

DEVELOPMENT OF METHODS TO USE SURFACTANTS IN BIRD CONTROL

History

The concept of using surfactants as lethal bird-control agents appears to have originated in late 1958 at the Patuxent Wildlife Research Center of the Bureau of Sport Fisheries and Wildlife. Biologist Dan L. Campbell, then assigned to the Center, noted that wild and penned blackbirds continued to bathe in available open water even during cold weather, and he theorized that exposure of wetting-agent solutions near roosting areas might result in death of bathing birds through chilling or freezing (D. L. Campbell, Personal communication). Although this approach was not field-tested, surfactant solutions were hand-sprayed on penned blackbirds in several tests at the Patuxent Center (Mitchell and Campbell, 1959), and at Patuxent's Gainesville, Florida, Substation (Spencer, 1960; H. J. Spencer and D. T. Harke, Personal communication). Laboratory screening tests also were conducted at Patuxent and Gainesville, and by a Patuxent contract investigator in Virginia (Lefebvre, 1961). All these early investigations indicated that the concept had promise.

Additional cage tests were conducted by personnel of the Bureau's Branch of Predator and Rodent Control (now the Division of Wildlife Services) in 1962 (Peterson, 1962a and 1962b) and 1963 (Bollengier, 1963). Results of these tests also were encouraging and led to development of the first method of field application (Bollengier, 1964). Night roosting birds were to be driven toward floodlights through a curtain of wetting-agent solution produced by spray nozzles mounted on standpipes. The equipment was field-tested with water only and worked well, except that the floodlights designed to attract the birds had the opposite effect.

Further testing of Bollengier's technique was conducted in 1966 at a Kentucky roost, but this time surfactant solutions were used and placement of floodlights was changed (Garner, 1966). About 20,000 birds were killed in 2 nights, with a total of 21.5 minutes of actual spraying during four drives. Additional trials of this application method in Ohio (Smith, 1967; Winters, 1968) were unsuccessful. A similar technique was tried in two urban roost situations: a sign framework in Michigan (Wetzel, 1967), and trees in New Mexico (Gustad, 1969). In both trials, spray nozzles were attached to the roost perches, but with little success.

A different ground-application technique was used by Carley (1966). Floodlights were used to attract birds driven through a curtain of vertical strings down which flowed wetting-agent solution. An estimated 80,000 to 90,000 starlings were killed in three field trials in holly orchards.

Because of problems associated with ground-application techniques, a research program was initiated in 1965 by the Patuxent Wildlife Research Center to evaluate aerial application of surfactant solutions on roosting birds. It was determined that candidate surfactants should have the following characteristics:

(1) Maximum surfactancy at minimum concentrations;

(2) Rapid biodegradation under aerobic and anaerobic conditions;

(3) Low toxicity to invertebrates, fish, and mammals; and

(4) Low phytotoxicity.

<u>Laboratory investigations</u>

Dr. Cooper H. Wayman, an authority on wetting agents at the Colorado School of Mines, evaluated commercially available and experimental materials while under contract with the Bureau. He is currently attempting to develop a technique for assessing the biodegradation of potential surfactant stressing agents. Dr. Wayman reported that the candidates who most nearly met the above specifications were: linear alcohol ethoxylates (LAE's) which are industrial synthetic detergents (syndets); certain soaps; and a group of experimental sucrose esters. Laboratory work was initiated on these materials to determine application rates necessary to kill birds under certain controlled environmental conditions, and to determine hazards of use.

Early laboratory tests consisted of using a finger-operated sprayer to apply various volumes and concentrations of candidate materials to birds. Treated birds, usually red-winged blackbirds (Agelaius phoeniceus), were then placed in a cold chamber, actually a modified freezer, and their reactions were noted. Subsequent mortality of treated birds in the cold chamber indicated optimum treatment levels for each surfactant. A similar technique is still being used, the major change being in the spray apparatus. The new sprayer is a modified agronomic-plot sprayer with variable pressure and interchangeable nozzles, permitting more accurate delivery and simulations of field applications. This sprayer is tractor-mounted and can be calibrated to produce high- or low-volume applications to caged birds.

Laboratory work also has involved testing for synergistic effects with combinations of surfactants, and with combinations of surfactants and contact avicides. No synergism has been found.

Investigations into the basic physiological mechanisms involved in surfactant-related mortality are being pursued at Patuxent's Ohio Substation. These include studies of energy production, energy utilization, and heat transfer in birds.

Candidate materials have been tested for toxicity to fish at the Patuxent Wildlife Research Center (Inglis et al., 1967), and at the Bureau's Fish Control Laboratory at LaCrosse, Wisconsin (Unpublished data, 1968-1970), where one of the materials also was tested on Daphnia. Toxicity depended on water temperature and hardness. Data in Table 1 indicate lower toxicity for the soaps and sucrose esters than for the LAE syndet. Although toxicities of linear alcohol ethoxylate were higher, these levels were not considered high enough to preclude field experimentation in properly selected environments.

Phytotoxicity studies have been conducted at Patuxent's Florida and Arkansas Substations, and by the Wisconsin Alumni Research Foundation under contract with the Bureau. Plants tested so far have been corn, cotton, rice, soybean, sugar cane, holly, and live oak. These tests have shown that LAE syndets can be moderately to severely toxic to young or actively growing plants when applied at high rates, and that sucrose esters are relatively non-toxic. Post-treatment observations of field-test areas have indicated that there are no apparent ill effects on plants which are dormant at the time of application of soaps or LAE syndets.

Table I. The toxicity of selected wetting agents to fish and Daphnia under controlled test conditions.

	96-hour LC50 in ppm		
Species	LAE*	soap	sucrose ester
Rainbow Trout (*Salmo gairdneri*)		1-38	3-21
Channel Catfish (*Ictalurus punctatus*)	3-6	33-36	38
Bluegill (*Lepomis macrochi rus*)	5-7	37-45	38
Daphnia sp.	3		

*linear alcohol ethoxylate

Laboratory data, thus far, indicate that the following low-hazard surfactants applied under proper environmental conditions will produce bird mortality:

(1) PA-14 (a linear alcohol ethoxylate);

(2) sodium or potassium oleate (soaps); and

(3) sucrose monolaurate (a sucrose ester).

FIELD TESTS USING AIRCRAFT TO DELIVER SURFACTANTS

High-volume applications of low-concentration solutions

Extreme caution has been used in the selection of experimental sites during the testing program in order to minimize the chances of adversely affecting plants and non-target animals. Until more complete toxicity information is acquired, tests are not conducted on areas supporting commercial or sport fisheries, timber, nursery stock, or agricultural crops. Surface and underground drainage patterns are carefully checked for destination and volume of flow to ensure that runoff and percolation will not contaminate streams, lakes, or domestic water supplies. Preferred test sites are those in which applied materials will remain in place, at least until degraded.

Prospective treatment sites also are checked for the presence of non-target animals. Robins, which sometimes roost with blackbirds and starlings, and ducks, which may use areas near wetland roost sites, are of particular concern in the Southeast, where most field trials have been conducted.

Using application rates based on laboratory data, field experimentation with aircraft was initiated during the winter of 1965-66 by Gainesville Substation personnel in cooperation with the U.S. Air Force (Caslick and Meanley, 1966). A C-123 spray aircraft was used to drop 950 gallons of 1.0 percent synthetic detergent solution on birds in a broadleaf-evergreen (pocosin) roost at Moody Air Force Base, Georgia. Three days after the drop a cursory inspection of the area revealed a low but undetermined number of dead redwings in the vicinity.

In the winter of 1966-67, field tests were continued at the Moody roost (Caslick and Stowers, 1967) and at a deciduous roost in Arkansas (Lefebvre et al., 1967). A spray-boom-equipped C-123 was unsatisfactory for low-concentration (2.5 percent solution) applications at Moody because of inadequate delivery volume. The next aircraft used was a B-26 modified for use as an aerial tanker in forest-fire fighting and capable of delivering its 1,000-gallon load over a 1-acre area. Initial test drops of 2.0 and 3.0 percent detergent solutions were made at the Moody roost. Although the dense vegetation precluded a systematic sampling of mortality, biologists estimated a kill of several thousand birds from the two drops. Survival of caged sunfish in the test plot did not differ significantly from that of caged fish in a control area. The same aircraft then was used in the Arkansas roost where drops of 1.0 and 0.2 percent detergent solutions, and applications of water, were made. The seven detergent drops, three water drops, and post-drop rainfall killed an estimated 78,000 blackbirds and starlings. Over 20,000 birds were killed as a result of one of the surfactant drops.

In both the Moody and Arkansas tests, residual mortality was noted. Additional birds died after contact with water through rainfall, bathing, or aerial water applications subsequent to surfactant application.

Further trials with the B-26 were conducted during the winter of 1967-68, but they yielded limited results. In a series of 17 applications of surfactant solution (0.2 to 2.0 percent) and 3 of water at the Moody roost, only about 4,175 birds were killed (Stickley et al., 1968). At two Arkansas roosts, an estimated 12,000 birds were killed in 14 drops of 0.1 to 1.0 percent surfactant solutions (Lefebvre et al., 1968). Concurrent laboratory work indicated that the probable cause of the limited field success was inadequate application volume.

Because of the relatively poor results obtained during the 1967-68 winter, a PB4Y2 tanker aircraft with a 2,000-gallon capacity was used in the 1968-69 winter. Results were encouraging (Lefebvre et al., 1970). In two Arkansas deciduous roosts, 10 syndet-solution and 6 soap-solution applications were made. Syndet concentrations, which ranged from 1.0 to 2.0 percent, resulted in mortalities of 300 to 42,000 birds per application. Soap concentrations of 1.2 to 3.0 percent produced kills of 1,290 to 24,000 birds, a 1/2-inch rainfall five nights after one of the soap applications resulted in an additional estimated 500-bird kill.

Because of funding limitations, large aircraft were not available during the 1969-70 roosting season. Therefore the high-volume, low-concentration technique could not be employed.

<u>Low-volume applications of high-concentration solutions</u>

In the high-volume tests we were, in effect, simulating rainfall (2,000 gallons/acre approximates a 0.1-inch rain). Once the efficacy of candidate surfactants had been demonstrated in high-volume tests, the next step was to evaluate low-volume, high concentration applications using small agricultural spray aircraft. Experimental application rates were based on laboratory and field data which indicated that, under favorable weather conditions, 20 gallons of actual LAE per acre are required for optimum results. Favorable results were obtained when this material was applied in one spray pass (80 gallons/acre of 25 percent solution), or when the same amount of actual LAE was applied in several passes with more dilute solutions (three 80 gallon/acre passes using 8.33 percent solution). Such application rates are possible from aircraft equipped with perforated-airfoil dispensers or venturi-type dry-material spreaders.

Low volume field experiments were initiated in the winter of 1967-68 when a roost near Morristown, Tennessee, was treated with an LAE syndet applied from a Grumman AgCat equipped with a boom-and-nozzle spray apparatus (Harke, 1968). The anticipated rain did not occur after the treatment, and less than 300 birds were found dead in the treated area. The same roost was treated during the 1968-69 winter, this time with a Grumman AgCat equipped with a perforated-airfoil dispenser (Lefebvre et al., 1970). Two applications were made at the rate of 200 gallons of 25 percent LAE solution per acre, but only about 1,900 birds were killed, probably because temperatures were not low enough.

The same aircraft was used the same year to apply 18 gallons of actual LAE per acre (as 5.0 percent solution) at a roost in Arkansas. The treatment and subsequent 0.1 inch of rainfall killed only 82 birds. The lowness of the kill probably was a result of inadequate volumes of surfactant and rainfall.

A Piper Pawnee equipped with a venturi spreader was used to make nine trial applications at two Georgia roosts during the 1968-69 winter (Hardy et al., 1970). All these treatments were made at the rate of 80 gallons of 25 percent LAE (20 gallons actual material) per acre applied in one spray pass. Mortality was high, 32,000 and 46,000 birds in two cases where windchill equivalent temperatures (see Falconer, 1968) in the mid-20's (°F) and rainfall over 0.3 inch followed treatment. When one or both of these conditions did not occur, neither did appreciable mortality.

In March 1969, the same type of aircraft was used to treat a roost of some 150,000 blackbirds and starlings near Columbus, Ohio. Application was at the rate of 80 gallons of 8.75 percent LAE solution per acre, repeated three times to give a total application of 21 gallons of actual syndet per acre. This was a slightly heavier application than that used in the Georgia tests. A combination of low windchill equivalent temperature (27°F) and substantial rainfall (0.55-inch) after the application killed about 144,000 birds, and virtually eliminated the roosting population.

Low-volume applications of LAE syndet, thus far, in 1970 have included two trials at a roost in Alabama occupied by an estimated half million blackbirds and starlings (Joe W. Hardy, Personal communication), and one at an Ohio roost containing a similar number of birds (Richard N. Smith, Personal communication). In the first Alabama test, treatment was at the rate of 80 gallons per acre of 12.5 percent LAE solution, repeated twice to total 20 gallons of actual surfactant per acre. The treatment, with subsequent windchill equivalent temperatures of 30° to 34°F and a 0.24-inch rainfall, killed an estimated 20,000 birds. Treatment in the second Alabama test was a single application of 25 percent LAE at 80 gallons per acre. In this instance, subsequent equivalent temperatures of 25° to 30°F and rainfall of 0.6 inch killed some 180,000 birds. A helicopter was used to treat the Ohio roost in March 1970 with 80 gallons per acre of 25 percent LAE solution. This application resulted in an estimated mortality of 294,000 blackbirds and starlings, with a nighttime low temperature of 50°F, no wind, and a 1-inch rainfall which continued throughout the next day.

Field tests of low-volume application methods so far have indicated some of the environmental conditions that produce significant bird mortality. As yet, we do not know the optimal conditions for maximum kills in any given situation. We know, however, that mortality is dependent on chilling temperature and rainfall following surfactant application. Best results to date have been obtained when conditions following surfactant treatment have included windchill equivalent temperatures of 24° to 34°F and rainfall of 0.5 inch or more. Under similar temperature conditions, mortality appears to vary with rainfall volume. As data from more field tests become available, better-defined parameters will be established.

The low-volume surfactant application technique obviously is not a panacea for the blackbird problem, but it continues to show promise as an effective tool for reducing populations in some situations. The greatest limitation is its dependence on certain weather conditions. Accurate forecasting of these conditions often is difficult, and several roost treatments may be necessary before anticipated weather occurs. Another limitation lies in site selection. Until completely safe physiological stressing-agents are developed, treatment must be limited to areas where application will result in a minimum of adverse environmental effects. In some cases, location of application equipment and personnel also can be problems. Crop-dusting services having the necessary equipment often are not locally available or, if they are, pilots may not be willing to make low-level nocturnal applications.

RESEARCH GOALS

Laboratory and field studies are being continued with a view toward improving the efficacy and safety of this technique. Specifically, research is directed towards:

(1) evaluating additional highly biodegradable surfactant materials;

(2) evaluating other contact physiological stressing agents (e.g., stimulants and depressants), used alone and in combination with wetting agents;

(3) continuing assessment of environmental hazards of candidate stressing agents; and

(4) evaluating helicopters and other aircraft as application vehicles.

LITERATURE CITED

BOLLENGIER, RENE M., JR. 1963. Effects of wetting agent on starlings. Unpublished memorandum report, Branch of Predator and Rodent Control, Bureau of Sport Fisheries and Wildlife, Amherst, Massachusetts. 4pp.

_____. 1964. Cage and field tests of wetting agents for starling control. Unpublished memorandum report, Branch of Predator and Rodent Control, Bureau of Sport Fisheries and Wildlife, Amherst, Massachusetts. 16pp.

CARLEY, CURTIS J. 1966. Wetting agents for bird control: background, summary of previous investigations, laboratory, cage, and field tests in Oregon's Willamette Valley. Supplementary report under Work Unit F-53.1, Denver Wildlife Research Center, Bureau of Sport Fisheries and Wildlife, Denver, Colorado. 37pp. + 20 Figs. [Processed.]
CASLICK, JAMES W., and BROOKE MEANLEY. 1966. Blackbird hazard to aircraft at Moody AFB, 1965-1966. Special Report under Work Unit F-27.1, Patuxent Wildlife Research Center, Bureau of Sport Fisheries and Wildlife, Laurel, Maryland. Upp. [Processed.]
_____, and JACOB F. STOWERS. 1967. Studies of wetting agents. Progress Report under Work Unit F-33.3, Patuxent Wildlife Research Center, Bureau of Sport Fisheries and Wildlife, Laurel, Maryland. 29pp. [Processed.]
FALCONER, RAYMOND. 1968. Windchill, a useful wintertime weather variable. Weatherwise (December):227-230.
GARNER, KENNETH M. 1966. Field test of the wetting agent technique for starling-blackbird roost control. Unpublished report, Division of Wildlife Services, Bureau of Sport Fisheries and Wildlife, Nashville, Tennessee, 4pp.
GUSTAD, ORVIS C. 1969. Bird control work-Tergitol 15-S-9. Unpublished memorandum report, Division of Wildlife Services, Bureau of Sport Fisheries and Wildlife, Albuquerque, New Mexico. 2pp + .1 Fig.
HARDY, JOE W., ALLEN R. STICKLEY, JR., and RAYMOND E. MATTESON. 1970. Effects of aerially-applied surfactant solutions on roosting blackbirds and starlings, January-March 1969. Part II. Georgia and Ohio. Special Report under Work Unit F-33.3, Patuxent Wildlife Research Center, Bureau of Sport Fisheries and Wildlife, Laurel, Maryland. [In process.]
HARKE, DONALD T. 1968. Field trial—aerial application of Tergitol 15-S-9, Lowland, Tennessee, February 20-25, 1968. Memorandum report, Division of Wildlife Services, Bureau of Sport Fisheries and Wildlife, Fremont, Ohio. 5pp.
INGLIS, ANTHONY, ROBERT T. MITCHELL, and JAMES V. RIFFLE. 1967. Toxicity of seven surfactants to fish in the laboratory. Special Report under Work Unit F-33.3, Patuxent Wildlife Research Center, Bureau of Sport Fisheries and Wildlife, Laurel, Maryland. 23pp. [Processed.]
LEFEBVRE, PAUL W. 1961. Blackbirds in southeastern Virginia: nesting productivity, depredations, and damage control methods. M.S. Thesis. Virginia Polytechnic Institute, Blacksburg, Virginia. 73PP. [Processed.]
_____, ALBERT E. HESTER, BROOKE MEANLEY, and DON P. FANKHAUSER. 1967. Effects of aerially-dropped surfactant solutions on roosting blackbirds and starlings in Arkansas, 1967. Special Report under Work Unit F-33.3, Patuxent Wildlife Research Center, Bureau of Sport Fisheries and Wildlife, Laurel, Maryland. 24pp. [Processed.]
_____, and DAVID W. SMITH. 1970. Effects of Aerially-applied surfactant solutions on roosting blackbirds and starlings, January-March 1969. Part I. Arkansas, Mississippi, and Tennessee. Special Report under Work Unit F-33.3, Patuxent Wildlife Research Center, Bureau of Sport Fisheries and Wildlife, Laurel, Maryland, [in process.]
, BROOKE MEANLEY, and DON P. FANKHAUSER. 1968. Effects of high-volume aerial surfactant applications on roosting blackbirds and starlings in Arkansas, 1968. Special Report under Work Unit F-33.3, Patuxent Wildlife Research Center, Bureau of Sport Fisheries and Wildlife, Laurel, Maryland. 14pp. [Processed.]
MITCHELL, ROBERT T., and DAN L. CAMPBELL. 1959. Studies of miscellaneous agents and techniques for lethal bird control. Third Quarterly Progress Report for the Fiscal Year 1959, Patuxent Research Refuge, Laurel, Maryland, p. 24. [Processed.]
PETERSON, JOHN W. 1962a. A new approach to starling control. Unpublished memorandum report, Branch of Predator and Rodent Control, Bureau of Sport Fisheries and Wildlife, Amherst, Massachusetts. 4pp. + 10 Tables.
_____. 1962b. A new approach to starling control. Supplement. Unpublished memorandum report, Branch of Predator and Rodent Control, Bureau of Sport Fisheries and Wildlife, Amherst, Massachusetts. 2pp.
SMITH, RICHARD N. 1967. Use of a wetting agent as a bird control tool. Unpublished memorandum report, Division of Wildlife Services, Bureau of Sport Fisheries and Wildlife, Columbus, Ohio. 5pp. + 1 Fig.
SPENCER, HENRY J. 1960. Studies of plumage penetrants useful in population control. Research Accomplishments for Fiscal Year 1960, Patuxent Wildlife Research Center, Laurel, Maryland, p. 143. [Processed.]
STICKLEY, ALLEN R., JR., PAUL W. LEFEBVRE, DON P. FANKHAUSER, and BROOKE MEANLEY. 1968. Effects of aerially-dropped surfactant solutions on roosting blackbirds at Moody Air Force Base, December 1967 and January 1968. Special Report under Work Unit F-33.3, Patuxent Wildlife Research Center, Bureau of Sport Fisheries and Wildlife, Laurel, Maryland. 16pp. [Processed.]
WETZEL, RICHARD S. 1967. Bird control—wetting agent test. Unpublished report, Division of Wildlife Services, Bureau of Sport Fisheries and Wildlife, Lansing, Michigan. 4pp. + 1 Fig.
WINTERS, RICHARD O. 1968. Use of a wetting agent as a bird control tool. Unpublished memorandum report, Division of Wildlife Services, Bureau of Sport Fisheries and Wildlife, Columbus, Ohio. 6pp.